Saskatchewan Agriculture, Food and Rural Revitalization

FARM Facts

Dry bean in Saskatchewan

Narrow-row production system

Introduction

Dry bean (*Phaseolus vulgaris*) is an ancient crop domesticated by aboriginal peoples of Central and South America. It is now grown in subtropical and temperate areas throughout the world, and during the cool, dry season in tropical areas. It is a relatively short-season crop, highly influenced by temperature. It has little frost tolerance and must be planted in late spring in Saskatchewan. Maturing bean plants do not have tolerance to early-fall frosts either, so the crop has a relatively narrow growing season range.

"Dry" bean refers to the end product, dry edible seeds.

Dry bean is the largest pulse crop in the world, with 16-17.5 million tonnes of annual production grown on over 25 million hectares (ha) or 60 million acres. Major producing countries are Brazil, USA, Mexico, and many countries in South America, East Africa and Asia.

In Saskatchewan, dry bean has been grown as a row crop for about 10 years in the irrigated area near Lake Diefenbaker. Dryland bean production in narrow-rows has begun in recent years. There were approximately 5,300 ha (13,300 acres) of dry bean production in Saskatchewan in 2001.

Manitoba plants about 80,000 ha (200,000 acres) of dry bean each year, grown mostly on dryland and in wide rows. Production in Alberta averages 16,000 ha (40,000 acres) each year and is limited to the irrigated area in the south where most production is grown in wide rows. Ontario producers have cultivated bean since 1850, and traditionally grow navy bean in wide rows. In the past decade, dry bean production in North America has been shifting to the mid-west, to the point where the largest producing areas are North Dakota and Minnesota.

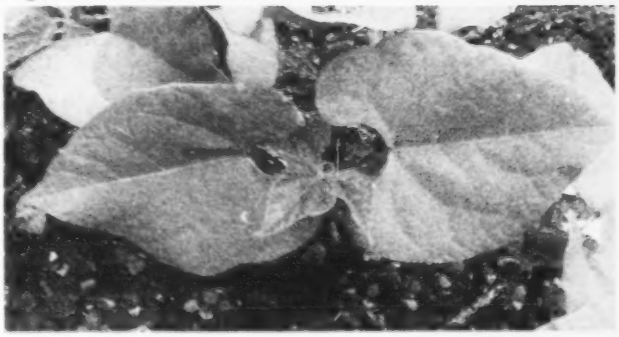
There are many types or market classes of dry bean. The most common classes grown in Western Canada are: pinto, navy, great northern, small red, pink and black. Smaller amounts of cranberry and various kidney types are also grown.

After germination, the cotyledons (seed leaves) push up through the soil and are exposed above the surface. The first true leaves (Figure 1) are single opposite leaves. All later leaves have three leaflets, called a trifoliate (Figure 2), arranged on alternate sides of the stem.

Flowers emerge from the upper leaf axils, and can be white, pink or purple in colour depending on the market class. The flowers are self pollinated before they open. Under heat or moisture stress, flowers can abort. Yields increase significantly, however, if excellent growing conditions occur at the time of flowering and pod formation.

Figure 1. First true leaves

Figure 2. Trifoliate leaves



103-02860/

Wide-row production

Wide-row production involves the planting of bean as a row crop with seed rows 55-90 cm (22-36 in.) apart. Specialized row crop equipment is needed for planting, inter-row cultivation, and harvest. This production system is very successful and often produces yields higher than narrow-row production.

For more information on wide-row production of dry bean, consult the Saskatchewan Pulse Growers publication, *Pulse Production Manual*; the Canada-Saskatchewan Irrigation Diversification Centre publication, *Crop Varieties for Irrigation;* or the other bean production information sites listed in *Additional Information*.

Narrow-row production

Narrow-row production of bean refers to solid seeding in row widths from 15-30 cm (6-12 in.). Some growers in Saskatchewan are interested in dry bean production where they can use their existing crop production equipment. Growers only need to make slight modifications to pea or lentil growing seeders, sprayers and harvest equipment. Narrow-row production can also affect the variety chosen, seeding rate, weed and disease control, and harvest practices.

This Farm Fact focuses on the narrow-row production system for non-irrigated dry bean production in Saskatchewan.

Market opportunities

Dry bean is the most widely traded pulse crop in the world. There are hundreds of market classes of dry bean produced depending on local traditions, tastes and demand.

Over 100 countries import dry bean. Major importers are Mexico, Brazil, Japan and the UK (Figure 3). However, imports to these countries make up less than half of world imports.

Major exporting countries are China, USA, Myanmar, Argentina and Canada (Figure 4). Annual world exports range from 2 to 2.5 million tonnes. Canada exports approximately 200,000 tonnes of dry bean annually, much of which goes to the UK and USA.

Due to the increased consumption of Mexican and Caribbean style foods, significant market opportunities exist in Canada for increased domestic use and exports of dry bean to USA, Mexico and Caribbean countries.

Dry bean is used almost exclusively as food and is therefore a high-value crop. Very little is used in livestock feed as it requires some processing before it can be fed. For this reason, growers must take extra care to maintain high quality in their dry bean crop.

Nutritional characteristics

Bean seeds contain 22-24 per cent protein and are high in dietary fibre and complex carbohydrates. Bean is gluten-free and low in sodium, making it suitable for low salt and gluten-free diets. Nutritional information for dry bean as a source of food is available from the Saskatchewan Pulse Growers Web site: **www.saskpulse.com**.

Figure 3. Major dry bean importing countries *(Source: FAO 2002)*

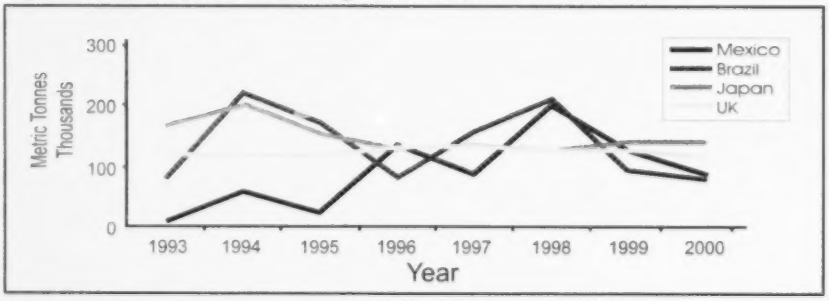
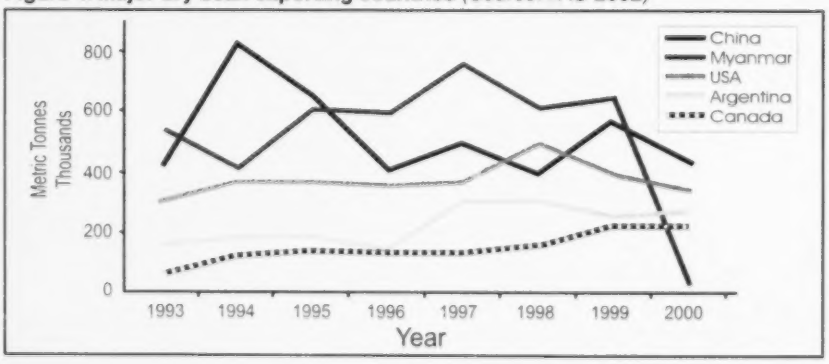


Figure 4. Major dry bean exporting countries *(Source: FAO 2002)*



Adaptation

Regional adaptation and field selection are two very important factors to consider when growing dry bean in narrow rows. Bean is not widely adapted to every region and soil type. The crop is best suited to medium-textured loams in regions that are not prone to late-spring or early-fall frosts. Because the crop has no frost tolerance, areas that are prone to frost should be avoided.

Early experience suggests that narrow-row production of dryland dry bean is best suited to the thin black soil zone where late summer rainfall amounts tend to be higher, and late-spring or early-fall frosts are typically not a high concern. Growers in other areas of the province are experimenting with dry bean production to determine if the crop is more widely adaptable than currently thought.

Rotational considerations

Dry bean crops leave little residue on the soil, so growers should consider protecting their fields from erosion by planting dry bean on cereal crop stubble and by following dry bean with a cereal crop. Previous crop residue must be chopped and evenly spread before planting.

Heavy crop residue slows soil warming in the spring, slowing germination and emergence of the crop, and increasing the risk of seed rot and seedling blight. For this reason, some growers prefer to plant dry bean on fallow fields.

Field records should be maintained to be aware of potential crop injury due to herbicide residue. Dry bean seedlings are susceptible to the soil residues of the following herbicides:

- Absolute
- Accord
- Ally
- Assert
- Attain
- Atrazine
- Banvel
- Bladex
- Curtail M
- Eclipse
- Everest
- K2
- Lontrel
- Muster
- FlaxMax
- Prestige
- Prevail
- Sundance
- Spectrum
- Tordon
- Unity.

Factors to consider when selecting a field for dry bean:

Drainage – Dry bean will not tolerate saline soils, wet soils or soils prone to any standing water. Saturated soil conditions for 24 hours will severely damage seedlings, usually leading to delayed maturity, and smaller and shrivelled seed.

Field history – Careful consideration should be given to the crop rotation history to ensure volunteer crops can be managed in the years of dry bean production. Bean is highly susceptible to Sclerotinia stem rot (white mould) and tight crop rotations including other broadleaf crops such as canola, mustard, pea, lentil, sunflower, and potato should be avoided. Dry bean seedlings are susceptible to the soil residues of some herbicides. See the section on *Rotational considerations* or check the SAFRR publication, *Guide to Crop Protection*, for more information.

Rocks and stones – A land roller should be used to level soil ridges and press any stones into the soil. Do not roll dry bean after emergence. Excessively stony fields should be avoided to prevent harvest equipment damage.

Soil temperature – Dry bean is better suited to soils that warm rapidly in the spring. Soils that are slow to warm or are covered by thick residue from the previous year's crop can lead to very slow bean emergence and development.

Other herbicides may have residues that could damage bean. Residues become of greater concern following dry years. See the SAFRR publication, *Guide to Crop Protection*, for more information on soil residual herbicides.

Dry bean should not be grown in the same field more often than once in four years to reduce the risk of soil-borne and residue-borne diseases. Sclerotinia stem rot (white mould) is a major concern in bean production, and planting bean in a field with a history of sclerotinia in other broadleaf crops within the past four years should be avoided.

Irrigation

Much of the dry bean production in Saskatchewan occurs in the irrigation area near Lake Diefenbaker. Bean yields are highest when no drought stress occurs during the flowering and pod-filling period. Irrigation is used to reduce losses due to drought. Irrigation increases the risk of white mould and delays the maturity of the crop. The Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) at Outlook, has carried out research on irrigated dry bean and should be contacted at (306) 867-5400 for more information.

Varieties

There are many bean classes and varieties grown successfully in wide-row production in Western Canada. For more variety information on wide-row production, check out the bean production information on the CSIDC, Manitoba Agriculture or the Alberta Agriculture, Food and Rural Development Web sites (see *Additional Information*).

There are three growth habits of dry bean (Table 1):

- Type I - determinate bush type;
- Type II - indeterminate bush type; and
- Type III - indeterminate vine type.

The determinate growth habit has five to nine nodes on the main stem with two to several branches. The main stem and branches end with a cluster of flowers. The indeterminate growth habit may have 12 to 15 nodes on the main stem. Vine types usually develop vines just before the start of flowering and flowers are produced along the vines.

Dry bean narrow-row regional variety trials have been carried out in Saskatchewan for six years. The results of these trials can be found in the SAFRR publication, *Varieties of Grain Crops*. Generally, the best bean varieties for dryland narrow-row production systems have early maturity and carry their pods higher off the ground to allow for the successful use of a swather or a straight-cut header. The pod clearance rating in Table 1 describes the per cent of pods that are at least 4.5 cm (2 in.) above the soil surface. In short season regions, only varieties with a maturity rating of "early" should be grown.

Inoculation

As a pulse crop, dry bean has the ability to fix a portion of its required nitrogen from air in the soil through a symbiotic relationship with soil bacteria called *Rhizobium*. Successful inoculation of dry bean requires the correct species of bacteria called *Rhizobium phaseoli*.

Table 1. Main characteristics of dry bean varieties grown under narrow-row (30 cm or less) production in Saskatchewan

Variety	Type or Market Class	Yield as % of CDC Pintium			Days to flower	Maturity	Pod clearance rating (%)	Seed (g/1000 seeds)	Growth Habit Type
		Area 2	Area 3	Irrigation					
CDC Pintium	pinto	100	100	100	50	Early	80	350	I
AC Polaris	great northern	71	94	106	52	Late	70	310	III
AC Redbond	small red	97	85	100	51	Late	65	290	II
CDC Altiro	pinto	86	77	102	47	Early	64	357	III
CDC Camino	pinto	86	76	97	52	Late	81	323	I
CDC Crocus	great northern	99	81	104	47	Early	59	355	III
CDC Expresso	black	78	66	55	47	Medium	87	191	I
CDC Minto	pinto	-	93	99	51	Late	62	410	III
CDC Nighthawk	black	61	67	61	58	Late	77	165	II
CDC Nordic	great northern	79	68	77	52	Late	62	319	I
CDC Pinnacle	pinto	103	98	102	53	Late	67	352	III
CDC Polar Bear	great northern	87	77	98	52	Late	65	339	III
CDC Rosalee	pink	97	85	100	50	Late	65	247	III
Earliray	pinto	89	80	82	50	Early	65	349	I
Othello	pinto	96	89	96	52	Late	51	323	III
UI906	black	93	71	80	60	Late	76	148	II
US 1140	great northern	87	81	88	51	Late	53	289	III
Viva	pink	94	102	80	51	Late	50	242	III

Source: Varieties of Grain Crops, SAFRR 2003

Varieties

There are many bean classes and varieties grown successfully in wide-row production in Western Canada. For more variety information on wide-row production, check out the bean production information on the CSIDC, Manitoba Agriculture or the Alberta Agriculture, Food and Rural Development Web sites (see *Additional Information*).

There are three growth habits of dry bean (Table 1):

- Type I - determinate bush type;
- Type II - indeterminate bush type; and
- Type III - indeterminate vine type.

The determinate growth habit has five to nine nodes on the main stem with two to several branches. The main stem and branches end with a cluster of flowers. The indeterminate growth habit may have 12 to 15 nodes on the main stem. Vine types usually develop vines just before the start of flowering and flowers are produced along the vines.

Dry bean narrow-row regional variety trials have been carried out in Saskatchewan for six years. The results of these trials can be found in the SAFRR publication, *Varieties of Grain Crops*. Generally, the best bean varieties for dryland narrow-row production systems have early maturity and carry their pods higher off the ground to allow for the successful use of a swather or a straight-cut header. The pod clearance rating in Table 1 describes the per cent of pods that are at least 4.5 cm (2 in.) above the soil surface. In short season regions, only varieties with a maturity rating of "early" should be grown.

Inoculation

As a pulse crop, dry bean has the ability to fix a portion of its required nitrogen from air in the soil through a symbiotic relationship with soil bacteria called *Rhizobium*. Successful inoculation of dry bean requires the correct species of bacteria called *Rhizobium phaseoli*.

Table 1. Main characteristics of dry bean varieties grown under narrow-row (30 cm or less) production in Saskatchewan

Variety	Type or Market Class	Yield as % of CDC Pintium			Days to flower	Maturity	Pod clearance rating (%)	Seed (g/1000 seeds)	Growth Habit Type
		Area 2	Area 3	Irrigation					
CDC Pintium	pinto	100	100	100	50	Early	80	350	I
AC Polaris	great northern	71	94	106	52	Late	70	310	III
AC Redbond	small red	97	85	100	51	Late	65	290	II
CDC Altiro	pinto	86	77	102	47	Early	64	357	III
CDC Camino	pinto	86	76	97	52	Late	81	323	I
CDC Crocus	great northern	99	81	104	47	Early	59	355	III
CDC Expresso	black	78	66	55	47	Medium	87	191	I
CDC Minto	pinto	-	93	99	51	Late	62	410	III
CDC Nighthawk	black	61	67	61	58	Late	77	165	II
CDC Nordic	great northern	79	68	77	52	Late	62	319	I
CDC Pinnacle	pinto	103	98	102	53	Late	67	352	III
CDC Polar Bear	great northern	87	77	98	52	Late	65	339	III
CDC Rosalee	pink	97	85	100	50	Late	65	247	III
Earliray	pinto	89	80	82	50	Early	65	349	I
Othello	pinto	96	89	96	52	Late	51	323	III
UI906	black	93	71	80	60	Late	76	148	II
US 1140	great northern	87	81	88	51	Late	53	289	III
Viva	pink	94	102	80	51	Late	50	242	III

Source: Varieties of Grain Crops, SAFRR 2003

When properly inoculated, the bean plant will form nodules on its roots where the bacteria convert nitrogen to a form that plants can use.

Generally, dry bean are poor fixers of nitrogen in comparison to pea, lentil, faba bean, and chickpea. Research completed on inoculated dry bean by the University of Saskatchewan and Agriculture and Agri-Food Canada (AAFC), Morden Research Station, indicated a positive yield response to the application of starter nitrogen at actual nitrogen rates of 25-75 kg/ha (22-67 lb./acre) when applied in conjunction with an effective rhizobial inoculant. This on-going research also indicates a difference between bean varieties with respect to their ability to fix nitrogen. For these reasons, the current recommendation for non-irrigated dry bean production in Saskatchewan is to inoculate the crop and use 55 kg/ha (50 lb./acre) starter nitrogen, broadcast or side-banded.

The use of some seed treatments can negatively affect nitrogen-fixing inoculant products. Generally, seed treatments should be applied to the seed first, allowed to dry, and then the inoculant applied just prior to seeding. The use of an in-furrow granular inoculant can minimize contact with treated seed. Consult the inoculant label for more information.

For more information on inoculation, consult the SAFRR publication, *Inoculation of Pulse Crops*.

Fertilization

Dry bean grows best in fertile soils, so soil samples should be taken and analyzed to provide an accurate assessment of the crop's fertility needs. Bean is very sensitive to seed-placed fertilizer, so all nitrogen, potassium and sulphur fertilizer must be placed away from the seed. Sidebanding fertilizer is recommended. The maximum phosphate level placed with the seed is 17 kg/ha (15 lb./acre) P_2O_5, based on 15-17 cm (6-7 in.) row spacing and under good to excellent seedbed moisture conditions.

For more information on the use of fertilizer, consult the SAFRR publication, *Guidelines for Safe Rates of Fertilizer Applied With the Seed*.

Nitrogen

The current recommendation for non-irrigated dry bean production in Saskatchewan is to inoculate the seed and use 55 kg/ha (50 lb./ac) starter nitrogen, broadcast or side-banded.

In research carried out at the University of Saskatchewan, inoculated bean had a yield response to the addition of nitrogen fertilizer, even when properly inoculated with a rhizobial inoculant. This research also indicated that different bean varieties have varying responses to the addition of starter nitrogen fertilizer. Excessive nitrogen applications may cause increased vegetative growth, delayed maturity and an increased risk to foliar disease.

Phosphorus

Phosphorus is extremely important for optimum nodule, flower and seed formation and advancing crop maturity. If phosphorus levels fall below 28 kg/ha (25 lb./acre), an additional 17 kg/ha (15 lb./acre) may be added. Seed placement of phosphate in excess of 17 kg/ha (15 lb./acre) can reduce plant stands. For higher rates of phosphate, dry seedbed conditions or wider row spacing, sidebanding phosphate fertilizer is recommended. The use of Jumpstart® inoculant is an alternative or supplement to adding phosphate fertilizer and is used to increase the availability of phosphorus to the plant. Check the Jumpstart label for more information.

Potassium

Most soils in Saskatchewan have high levels of available potassium, and thus the addition of potassium fertilizer is often not required. Potassium levels may be low on sandy soils and may require potassium fertilizer. If potassium fertilizer is required, consider blending it with nitrogen and side-band it away from the seed.

Sulphur

If a soil test indicates sulphur deficiencies, plant-available forms of sulphur fertilizer can be side-banded. Sulphur fertilizer can be added to the crop preceding dry bean as a management option.

Micronutrients

Zinc deficiencies can occur in dry bean. However, research in Saskatchewan has not yet identified widespread zinc deficiency problems. Navy bean tends to be more susceptible to a zinc deficiency than coloured bean, and recent research indicates that zinc deficiency may be variety specific. Zinc deficiencies are expected to occur first under irrigation and on sandy soil, and will most likely be seen in isolated patches within the field. Symptoms include yellowing of the newest leaves and the area between the leaf veins, while the veins remain green. Bean plants tend to be stunted due to shortening of the internodes. Bronzing of the older lower leaves, crinkled appearance of the leaves that curl downward and poor pod set are also symptoms of zinc deficiency.

Tissue and soil samples of unaffected and suspect areas in the field should be taken and analyzed to confirm a zinc deficiency. Zinc can be applied with the fertilizer blend and side-banded at seeding time or foliar applied as needed. Use the plant-available forms of zinc fertilizer.

Low soil temperatures or wet soils in the spring may lead to iron or zinc deficiency symptoms in dry bean that should become less evident in a few days when the soil warms and excess moisture is gone.

Seeding

The narrow-row production system for dry bean allows the use of seeding equipment designed for other crops. Bean crops seeded with airseeders or other solid-seeding implements emerge in rows 15 to 30 cm (6-12 in.) apart which do not allow between-row cultivation. The use of tramlines should be considered in narrow-row bean production to avoid wheel track damage to emerged bean plants. Damaged plants often mature later, complicating harvest timing.

Dry bean seedlings can display a condition called baldhead, where only the cotyledons and seedling stem emerge, and no leaf development occurs (Figure 5). Baldhead is caused by mechanical injury to the seed during handling or seeding, especially when seed moisture content is below 14 per cent.

Figure 5. Baldhead of dry bean seedling

To reduce baldhead, the airseeder fan speed and ground speed should be reduced as much as possible while still maintaining proper seed distribution. Some airseeders can be modified with deflector pads within the seed delivery manifolds to reduce seed cracking. Belt conveyors are available on some new airseeders to reduce mechanical injury while loading.

Baldhead can also be reduced by using seed that is 14 per cent moisture or higher. Bean growers have learned to soak their seed before planting to slightly moisten the seed coat and reduce mechanical injury while seeding. This can be done by suspending a mini-bulk bag containing the seed and running water into the top of the bag until the excess water runs out the bottom of the bag. This process should be repeated after eight hours. After thoroughly wetting the seed, it should be allowed to temper for at least 24 hours before the seed is placed in the seed tank. Wetting the seed should be done before applying seed treatment fungicides (See Disease Control) or inoculant. Extra care must be taken when handling bean seed.

Seed treatment fungicides can be applied to the seed to reduce the risk of seed-borne and soil-borne seed rot and seedling blight of dry bean. See Disease Control or consult the SAFRR publication, *Guide to Crop Protection*, for more information.

In Saskatchewan, dry bean should be seeded between May 25 and June 5. Earlier planting increases the risk of seedling death due to late-spring frosts. Seeding later increases the risk of crop injury by early-fall frosts. Seeds germinate and develop slowly if the average soil temperature at depth of seeding is less than 12°C.

The recommended seeding depth for dry bean is 5-6 cm (2-2½ in.). Dry bean seed is comparatively large and absorbs moisture from the soil when it germinates and starts to develop. For this reason, the seedbed should be moist for proper growth. Shallow seeding increases the risk of the seedling drying out after germination,

while seeding too deep weakens seedlings and increases the risk of soil-borne diseases.

Seeding rates for dry bean depend on the seed size (Table 1). The target plant population for narrow-row production of the crop is 45 plants per m^2 (four plants per $ft.^2$). Higher seeding rates are required for narrow-row production of varieties with determinate (Type I) growth habit. Varieties with an indeterminate growth habit require a lower seeding rate because the individual plants are larger and are able to close the crop canopy more rapidly. Higher seeding rates can increase the risk of foliar diseases, such as white mould, under high moisture conditions.

Ensure that seeding equipment delivers seed uniformly at an even seeding depth. A common problem for first time growers is the occurrence of gaps in the seed row followed by dense numbers of seedlings due to uneven seed flow. The gaps allow weeds to become established, and the dense bean areas can increase the risk to plant diseases.

The *Pulse Production Manual* (see *Additional Information*) contains more information on bean seeding rates and number of seeds per linear foot of seed row for varying seeding rates and row spacing.

The following formula should be used to calculate the proper seeding rate.

$$\text{Seeding rate (lb./acre)} = \frac{(\text{population/ft}^2 \times 1000 \text{ seed wt. g}) \times 10}{\%\text{ field emergence or survival}}$$

Land rolling

Land rolling of fields seeded to dry bean is done to level soil ridges and push any stones into the soil surface to ease harvest and reduce earth tag. Rolling should be done immediately after seeding or up to three days after seeding. Land rolling of dry bean should not be done after seed germination or emergence of the crop as this practice will most likely break the stems of seedlings. Unlike pea, lentil or chickpea, dry bean seedlings do not have the ability to regrow from scale nodes if damage to the stem occurs.

Weed control

Dry bean is a short stature crop that does not often form a complete canopy until mid-July. It is a very poor competitor to weeds and must be grown on fields that are relatively weed free. Control of perennial weeds such as Canada thistle and sow-thistle must be done in the year previous to dry bean production.

As dry bean is not seeded in Saskatchewan until May 25, there is time to apply a pre-emergent burn-off herbicide to control early emerging and perennial weeds before the crop emerges. Bean is susceptible to the soil residues of many of the herbicides used for broadleaf weed control prior to seeding with the exception of glyphosate, Gramoxone, and Pardner/Koril. This may make the control of glyphosate-resistant canola volunteers more difficult.

Plants in the wheel tracks of ground sprayers/applicators in emerged crops may be later maturing than the rest of the crop. This can seriously complicate the timing of harvest. Tramlines should be considered in narrow-row bean production to reduce this problem.

The following herbicides are registered for control of grassy weeds in dry bean:

- Assure II
- Edge
- Frontier
- Fusion
- Hoe-Grass 284
- Poast Ultra
- Pursuit
- Select
- trifluralin

Basagran, Edge, Pursuit, and trifluralin herbicides are registered for the control of broadleaf weeds in dry bean. Be sure to check the herbicide labels before application because some products are not registered on all classes of dry bean. For example, Pursuit is registered on pinto, pink and red varieties only.

For an up-to-date list of registered herbicides, consult the product labels or the SAFRR publication, *Guide to Crop Protection*.

Early application of herbicides is important to control weeds and improve yields. Green weeds at harvest time can lead to staining and downgrading of the crop. Successful control of broadleaf weeds is a very important factor in narrow-row bean production as no between-row cultivation is possible. Some solvent burning may occur on the crop leaf surface, but experienced bean growers have found that often a second application of post-emergent broadleaf weed herbicide is required for improved yields and to reduce harvest problems with weeds.

Dry bean seedlings are susceptible to the soil residues of some herbicides (see *Rotational Considerations*). The SAFRR publication, *Guide to Crop Protection* contains more information on herbicides with soil residue considerations.

Dry bean seedlings are very sensitive to spray drift from herbicides for broadleaf weed control found in Herbicide Group two and four, and from glyphosate, Liberty, and Amitrole.

Pre-harvest perennial weed control with glyphosate is registered in dry bean. Application should be done when the seed moisture is below 30 per cent, the stems are green to brown and the pods are mature, with 80 to 90 per cent of leaves already dropped. *Do not use planting seed that has received a pre-harvest application of glyphosate.*

Disease control

Seedling diseases

Dry bean suffers from a complex of seed rot and seedling blight diseases caused by *Fusarium*, *Rhizoctonia* and *Pythium*. These disease pathogens are present in all Saskatchewan agricultural soils and can infect and kill individual seedlings from the germination to the pod-filling stage. Lesions develop at the base of the stem, causing discolouration and constriction of the stem. Diseased plants turn yellow and die. Usually, only scattered plants are infected. However, these diseases can cause economic loss. Fusarium is more serious in dry years and plants suffering from the disease show stunted yellowed leaves, form fewer pods and produce smaller seeds.

The best way to prevent seedling disease is to observe a proper crop rotation where dry bean is planted no more than once in four years. The use of vigorous seed can reduce the risk of seed rots and seedling blights.

A number of seed treatment fungicides are registered on dry bean for the control of seedling diseases including Vitaflo 280, Thiram 75WP, Captan, DCT, DLC, Agrox D-L Plus, Agrox B-3, Agrox CD, Agrox B-2, Allegiance FL, and Apron FL.

These fungicides can impact the viability of nitrogen-fixing inoculant products. The use of an in-furrow granular inoculant can minimize contact with treated seed. Always check the inoculant label or contact the manufacturer for more information on the compatibility of seed treatment fungicides and inoculants.

Bean common mosaic virus
Yellow mosaic virus

Dry bean seedlings can suffer from bean common mosaic virus or yellow mosaic virus. The symptoms include stunted and spindly plants, producing few pods and small, off-colour seeds. Leaves appear puckered and twisted.

The virus is spread by insects such as leafhoppers, and can also be spread by planting infected seed. Bean plant breeders have developed varieties that are resistant to a number of strains of viruses. Growers should use virus-free seed to prevent the diseases.

Rust

Rust (*Uromyces phaseoli*) of dry bean is not common in Saskatchewan and occurs primarily on pinto varieties. Symptoms include the development of slightly raised, rust-coloured pustules on the leaves. These pustules often have a yellow halo.

Rust infection is favoured by moderate temperatures (16 to 25°C) and 10 to 18 hours of leaf wetness. Infection and pustule development is greatly reduced if dry and warm conditions occur.

Bacterial blight

Several species of bacteria can cause blight in dry bean, but the two most common are common blight (*Xanthomonas campestris pv. phaseoli)* and halo blight (*Pseudomonas syringae pv. phaseolicola*). These foliar diseases are favoured by wet, windy weather, and can be spread through the field by mechanical operations and hail. Symptoms include lesions on leaves and stems, which start as small water-soaked spots. These small spots coalesce into large brown lesions and are surrounded by a yellow margin (halo). A crop rotation with at least two years between bean crops will help to reduce the risk of the disease.

Sunscald or herbicide solvent burn can cause similar symptoms as bacterial blights. Make sure the problem has been properly identified before control measures are taken.

Common and halo blights are seed-borne and residue-borne. The use of bacteria-free seed is essential to prevent the disease. Cupric Sulphate Pentahydrate is registered as a tank-mix with Vitaflo 280 seed treatment for the control of seed-borne bean blights.

Streptomycin seed treatment is used to reduce seed-borne bacterial diseases. Importation of bean seed treated with streptomycin will be allowed in the 2003 crop year. Special labelling requirements remain in effect and all seed bags must be tagged with instructions on the proper handling of streptomycin treated seed.

Copper-based foliar fungicides are registered for control of bacterial blight in dry bean.

White mould

White mould (*Sclerotinia sclerotiorum)* is a major foliar disease of dry bean and can cause severe crop loss. White mould is almost always present on irrigated dry bean. Narrow-row production can also increase the risk of white mould due to limited air movement under the crop canopy. The disease is most common in fields that were recently planted to other susceptible broadleaf crops such as canola, mustard, pulses, or sunflower. Resultant crop losses are heaviest if wet weather occurs during the flowering stage.

Disease spores germinate on fallen flower petals and rapidly produce lesions that begin as small water soaked spots, often first appearing at branches of the stem. The lesions rapidly expand and are often covered by a white cottony growth.

Whole plants can be killed if the lesions girdle the main stem. Infected pods produce small, discoloured seed. Small, black, hard bodies (sclerotia) form within the lesions and fall to the ground where they can remain dormant for up to five years. When conditions are right, these black bodies develop spore-producing structures.

To reduce the risk of white mould, avoid crop rotations with a history of susceptible broadleaf crops within the three previous years, and avoid planting bean crops adjacent to fields infected with the disease in the previous year.

Begin field scouting for white mould just prior to the flowering stage of the crop. Early signs include the presence of individual yellow or wilted stems and very small mushroom-like, spore-producing structures on the soil surface under a thick canopy.

Benlate, Ronilan EG and Senator 70WP (white bean only) foliar fungicides are registered for the control of white mould on dry bean. If warm, humid conditions occur and the crop canopy is dense, the application of the fungicide should take place when 10 to 30 per cent of the plants have at least one open bloom. Growers of dry bean should budget for an application of fungicide for the control of white mould.

Anthracnose

Anthracnose (*Colletotrichum lindemuthianum*), a serious disease of dry bean in other areas of the world, is not a problem in Saskatchewan. It is seed-borne and residue-borne, and can be avoided by using disease-free seed and a crop rotation with at least three years between bean crops. The fungus that causes anthracnose on dry bean is different from that causing anthracnose on lentil.

The proper identification of any crop disease can be difficult. Bean seed should be tested at an accredited seed test laboratory for germination, vigour and the presence of seed-borne diseases. The provincial Crop Protection Laboratory in Regina (306-787-8130) provides foliar disease identification for a fee. Contact your local Rural Service Centre for a fee schedule and instructions for proper sample collection and transportation.

For more information on fungicides and their use, consult the product labels or the SAFRR publication, *Guide to Crop Protection*.

Insect Control

Grasshopper

Grasshopper damage occurs on leaves and can be severe on field edges after adjacent crops have matured.

Cutworm

Cutworms often feed at night, chewing through the seedling stem just below the soil surface. They do most of their damage in late spring, and will attack many broadleaf crops, including dry bean. Red-backed and Pale Western cutworm are two common species affecting dry bean in Saskatchewan.

Bean crops should be scouted regularly. If wilted, dead or cut off seedlings are noticed, dig around the roots of the plant to check for the presence of cutworms. There are no registered insecticides for cutworm control in dry bean.

Seedcorn maggot

Seedcorn maggots can attack bean seed after planting. They prevent germination or weaken seedlings. The yellowish white maggot can be found burrowing in the seeds or emerging stems.

Seedcorn maggots are usually most severe in wet, cold seasons and when delays in germination and emergence occur. Agrox B-3, Agrox D-L Plus, and DLC are registered seed treatments for seedcorn maggot control on dry bean. If maggot pressure is extremely high, replanting with treated seed may be the only option. Seedcorn maggot infestations are generally not widespread and can be variable within fields and between adjacent fields.

Potato leafhopper

Adult potato leafhoppers are slender, 2.5 mm (1/10 in.) long, light green, and have short, bristle-like antennae. The female lays eggs on plants and the nymphs hatch in about 10 days. Both adults and nymphs suck sap from the vascular tissue of the plant. By July, a sufficient population of leafhoppers can be present to cause stunted plants that may eventually die.

The economic threshold for insecticide application is one leafhopper per trifoliate leaf. Cygon, Di-Syston, Sevin XLR Plus, Malathion, Fyfanon, and Methoxychlor are registered for control of potato leafhopper on bean.

Lygus bug (Tarnished plant bug)

Hot, dry weather favours an increase in the population of lygus bug and increases the possibility of damage to bean seedlings. Lygus bugs have piercing mouth parts that suck sap from the plant. Cygon, Dylox, Sevin XLR Plus and Thimet are registered for the control of lygus bug on bean.

Consult the product labels or the SAFRR publication *Guide to Crop Protection* for more information.

Sunscald

Following sunny, hot weather, dry bean can exhibit small brown irregular spots between the veins. The spots expand, often leaving large areas of dead tissue between healthy green veins. Bronzing occurs when upper leaf surfaces are covered with small golden-brown spots, which make the leaf appear bronze in colour. No controls are suggested.

Desiccation

Reglone® desiccant is registered for use on dry bean. The product is used to evenly dry-down the crop and weeds to hasten harvest. It will not speed the maturity of the crop. Apply to dry bean when 80-90 per cent of the leaves have dropped and 80 per cent of the pods have turned yellow. For more information on desiccation of dry bean, consult the product label.

Harvesting

Timely harvest is extremely important for maintaining food grade quality, seed coat colour and seed viability. Price declines occur rapidly as quality worsens.

Harvest losses can be as high as 40 per cent in narrow-row dry bean and extra care must be taken by the grower to prevent loss. Crop development stages must be very closely monitored to determine the best time to harvest, especially for determinate types. Successful weed control is critical for swathing or straight cutting dry bean. Bean plants in the wheel tracks of sprayers often are delayed and may still be green when the rest of the crop is ready to be harvested. Over-ripe pods are prone to shattering and seeds are lost if harvest is delayed.

The buckskin stage of dry bean occurs when pods turn yellow and flexible, and is an important crop stage to become familiar with when determining harvest timing.

Many producers in Saskatchewan and western Manitoba, growing determinate dry bean varieties in the narrow-row production system, are choosing to cut their crop using a swather. The choice of swather model is a very important harvest decision. Some models are able to cut dry bean with very little loss.

A swather equipped with vine-lifters and a pick-up reel allows the crop to be cut when the majority of the field is in the proper stage, even though some lower areas or wheel tracks are less mature. Immature plants will dry down in the swath, and harvest losses due to shattering and earth tag are reduced.

Varieties with a high pod clearance rating (Table 1, page 4) must be grown in order to be successful using a swather.

Swath when about 50-60 per cent of the pods are in the buckskin stage, when the pods have turned from green to yellow and are still flexible. At this stage, many of the leaves are yellow and approximately half the leaves will have dropped from the plants. Swathing when some leaves still remain on the plant may be beneficial for varieties with determinate growth habit and short stature.

If stems are moist, the swather knife may gum up, requiring periodic cleaning. Swaths are prone to wind damage for the first few days. Plants will rot in the swath if excessive moisture occurs after swathing. If pod moisture is too low, excessive shattering can occur during swathing. If these conditions occur, swathing should be delayed until early morning or late evening.

Combine when the seed moisture content reaches approximately 18 per cent. Seed is easily damaged during harvest and handling. Cylinders or rotors should be run only fast enough to thresh the crop, and as much material as possible should be run through the cylinder to minimize damage. New rub bars and concaves should be "worn" before harvesting dry bean. Concave wires can be removed to allow the flow of large seeds. The clean grain, return and unloading augers should be checked and properly adjusted to reduce sharp edges. Unloading augers should be operated full and slowly.

Straight-cut harvesting of dry bean is feasible as long as the crop is evenly mature and the pods are high enough above the soil surface to allow the cutter bar to pass under them. Headers can be modified with vine lifters or pod lifters designed for direct harvesting of dry bean. Choose a header size that closely matches the combine capacity for even flow through the machine with minimum damage to the seed.

Straight cutting should begin when approximately 75 per cent of the pods are hard and dry with the remainder in the buckskin stage. The crop can be left standing until a killing frost dries the crop and remaining immature weeds. Excessive harvest losses can be avoided by selecting crop varieties with a high pod clearance rating (see Table 1).

After the crop matures past the buckskin stage, it is subject to fluctuations in moisture content depending on the time of day and weather conditions. Keep checking the sample throughout the day and adjust the combine accordingly.

On hot, dry days, the pod moisture can decrease rapidly leading to increased pod shattering. If seed moisture falls below 13 per cent, excessive seed damage can occur. Low pod moisture conditions are indicated by the presence of open pods on the cutter bar. If this occurs, it may be advantageous to wait until the pod moisture content increases.

Pod moisture may be too high in early morning or late evening, causing difficulty in threshing the seed from the pod. High moisture conditions can also lead to increased soil sticking to the seed – referred to as earth tag.

Storage and handling

Steel flighting augers are not recommended for dry bean. The use of a belt conveyor will greatly reduce seed damage while moving the seed in and out of storage. The installation of a bean ladder within the grain bin allows it to be filled without damaging the seed.

Some bean marketing companies prefer to take delivery of the crop immediately from the combine to reduce mechanical damage to the seed.

Dry bean is often stored at 17 per cent moisture. However, 16 per cent is considered dry.

For long-term storage, moisture content should be lowered to 15 per cent. Bins equipped with aeration are required to cool and dry the sample and reduce losses due to spoilage. Weed seeds and other dockage should be removed to avoid spoilage and down-grading of the crop. Bean seed should not be handled at temperatures below -20°C or when the seed moisture content is below 13 per cent to avoid mechanical damage. Supplemental heat drying temperatures should be restricted to a maximum of 38°C to avoid germination loss.

Grading

Dry bean grading is done by the Canadian Grain Commission. Factors such as damaged or heated seeds, foreign material, disease, seed uniformity and the presence of off-types are considered when establishing a grade.

Marketing

A list of dry bean buyers and marketers is available in the SAFRR publication, *Saskatchewan Special Crop Marketing Company Synopsis*. Several marketing companies offer production contracts, crop inputs and production advice for dry bean growers.

Economics of production

The SAFRR publication, *Crop Planning Guide - Specialty Crops*, includes information on projected costs of production and expected returns of pinto bean in narrow-row production systems in Saskatchewan.

Additional information

The following publications are available at your Rural Service Centres or on-line at: **www.agr.gov.sk.ca**

Guide to Crop Protection

Varieties of Grain Crops

Inoculation of Pulse Crops

Guidelines for Safe Rates of Fertilizer Applied With the Seed,

Saskatchewan Special Crop Marketing Company Synopsis

Crop Planning Guide - Specialty Crops

Crop Varieties for Irrigation
Canada-Saskatchewan Irrigation Diversification Centre
(306) 867-5400
Web site:
www.agr.gc.ca/pfra/sidcgene.htm

Pulse Production Manual
Saskatchewan Pulse Growers
(306) 668-5556
Web site: **www.saskpulse.com**

Field Bean Production Systems
Manitoba Agriculture
Web site: **www.gov.mb.ca**

Pulse Crops in Alberta
Alberta Agriculture, Food and Rural Development
Web site: **www.agric.gov.ab.ca**

Dry Bean Production Guide
North Dakota State University
Web site:
www.ext.nodak.edu/extpubs/plantsci/rowcrops/a1133-1.htm

Dry bean fact sheets
Colorado State University
Web site: **www.colostate.edu/Orgs/VegNet/vegnet/beans.html**

Contributors:
R. McVicar, K. Panchuk, C. Brenzil, S. Hartley and P. Pearse, Saskatchewan Agriculture, Food and Rural Revitalization

A. Vandenberg, S. Banniza, F. Walley, University of Saskatchewan

L. Shaw, Canada-Saskatchewan Irrigation Diversification Centre

Saskatchewan Agriculture, Food and Rural Revitalization

December 2002
3M ISSN 0840-9447 CD0105